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MIDDLE LAKE, WALWORTH COUNTY, WISCONSIN. EPA REGION V

Pacific Northwest Environmental Research Laboratory

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National Environmental Research Center
Wisconsin Department of Natural Resources
Wisconsin National Guard

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U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

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REPORT
ON
MIDDLE LAKE
WALWORTH COUNTY
WISCONSIN
EPA REGION V
WORKING PAPER No. 70

WITH THE COOPERATION OF THE
WISCONSIN DEPARTMENT OF NATURAL RESOURCES
AND THE
WISCONSIN NATIONAL GUARD

JULY, 1975

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS*

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

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* The lake discussed in this report was included in the National Eutrophication Survey as a water body of interest to the Wisconsin Department of Natural Resources. Tributaries and nutrient sources were not sampled, and this report relates only to the data obtained from lake sampling.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Wisconsin Department of Natural Resources for professional involvement and to the Wisconsin National Guard for conducting the tributary sampling phase of the Survey.

Francis H. Schraufnagel, Acting Assistant Director, and Joseph R. Ball of the Bureau of Water Quality, and Donald R. Winter, Lake Rehabilitation Program, provided invaluable lake documentation and counsel during the Survey. Central Office and District Office personnel of the Department of Natural Resources reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper series.

Major General James J. Lison, Jr., the Adjutant General of Wisconsin, and Project Officer CW-4 Donald D. Erickson, who directed the volunteer efforts of the Wisconsin National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

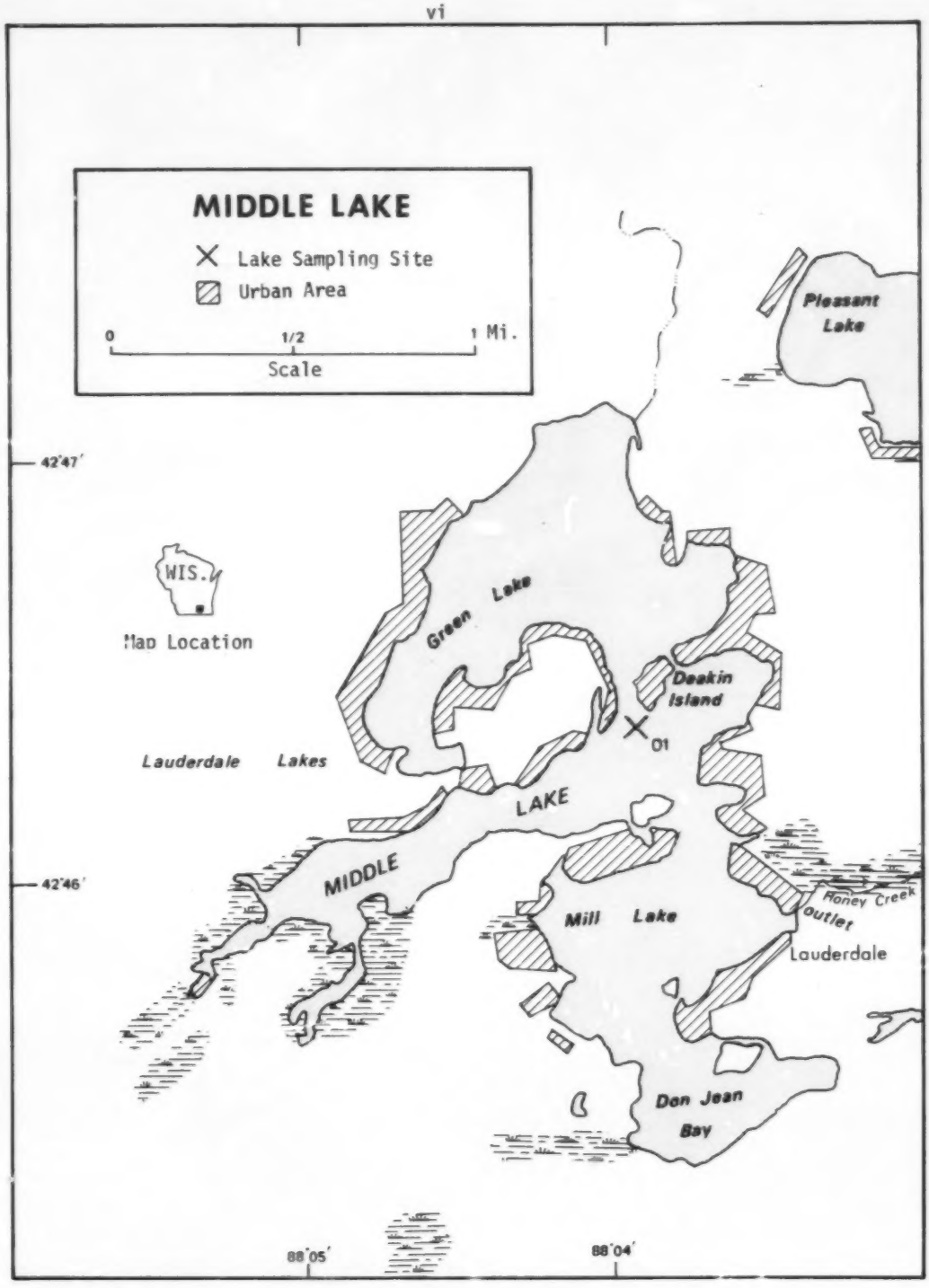
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF WISCONSIN

LAKE NAME	COUNTY
Altoona	Eau Claire
Beaver Dam	Barron
Beaver Dam	Dodge
Big Eau Pleine	Marathon
Browns	Racine
Butte des Morts	Winnebago
Butternut	Price, Ashland
Castle Rock Flowage	Juneau
Como	Walworth
Crystal	Vilas
Delavan	Walworth
Eau Claire	Eau Claire
Geneva	Walworth
Grand	Green Lake
Green	Green Lake
Kegonsa	Dane
Koshkonong	Jefferson, Rock, Dane
Lac La Belle	Waukesha
Middle	Walworth
Nagawicka	Waukesha
Oconomowoc	Waukesha
Okauchee	Waukesha
Petenwell Flowage	Juneau
Pewaukee	Waukesha
Pigeon	Waupaca
Pine	Waukesha
Poygan	Winnebago, Waushara
Rock	Jefferson
Rome Pond	Jefferson, Waukesha
Round	Waupaca
Shawano	Shawano
Sinnissippi	Dodge

LAKE NAME	COUNTY
Swan	Columbia
Tainter	Dunn
Tichigan	Racine
Townline	Oneida
Trout	Vilas
Wapogassett	Polk
Wausau	Marathon
Willow	Oneida
Winnebago	Winnebago, Fond Du Lac, Calumet
Wisconsin	Columbia
Wissota	Chippewa
Yellow	Burnett


MIDDLE LAKE
Lake Sampling Site
Urban Area
0
1/2
1 Mi.
Scale
Pleasant Lake
42°47'
WIS.
Map Location
Green Lake
Deakin Island
01
Lauderdale Lakes
LAKE
MIDDLE
42°46'
Honey Creek Outlet
Mill Lake
Lauderdale
Don Jean Bay
88°05'
88°04'

MIDDLE LAKE

STORET NO. 5569

I. INTRODUCTION

Middle Lake was included in the National Eutrophication Survey as a water body of interest to the Wisconsin Department of Natural Resources. No wastewater treatment plants impact the lake, and there are no well-defined tributaries. Therefore, this report is concerned only with the lake sampling data.

Middle Lake is located between Green Lake and Mill Lake in what is known as the Lauderdale Chain; at one time the three lakes were separate, but they now are broadly connected by shallow channels which were formed when a ten-foot dam was constructed on the Honey Creek outlet of Mill Lake (Poff, et al., 1969).

II. CONCLUSIONS

A. Trophic Condition:

Survey data and reports of others (Lueschow, et al., 1970; Poff, et al., 1969) indicate Middle Lake is meso-eutrophic. Of the 46 Wisconsin lakes sampled, one had less and one the same mean total phosphorus, one had less and two the same mean dissolved phosphorus, 36 had less mean inorganic nitrogen, five had less mean chlorophyll a, and three had greater Secchi disc transparency. Dissolved oxygen was depleted at the 46-foot depth in August, 1972.

Middle Lake has had extensive weed-control activity (Lueschow, et al., 1970).

B. Rate-Limiting Nutrient:

The results of the algal assays indicate Middle Lake was phosphorus limited at the time the sample was taken (11/10/72). The lake data indicate phosphorus limitation at the other sampling times as well.

III. LAKE CHARACTERISTICS

A. Lake Morphometry*:

1. Surface area: 259 acres.
2. Mean depth: 10.4 feet.
3. Maximum depth: 42 feet.
4. Volume: 2,701 acre-feet.

B. Precipitation**:

1. Year of sampling: 38.7 inches.
2. Mean annual: 30.7 inches.

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* McElwie, 1972.
** See Working Paper No. 1, "Survey Methods, 1972".

IV. LAKE WATER QUALITY SUMMARY

Middle Lake was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at a single station on the lake (see map, page vi). During each visit, a single depth-integrated (15 feet to surface) sample was collected for phytoplankton identification and enumeration, and a similar sample was taken for chlorophyll a analysis. During the last visit, a single five-gallon depth-integrated sample was collected for algal assays. The maximum depth sampled was 46 feet.

The results obtained are presented in full in Appendix A, and the data for the fall sampling period, when the lake essentially was well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix A.

A. Physical and chemical characteristics:

FALL VALUES

(11/10/72)

Parameter	Minimum	Mean	Median	Maximum
Temperature (Cent.)	7.1	7.4	7.5	7.5
Dissolved oxygen (mg/l)	8.8	8.9	8.9	9.1
Conductivity (μmhos)	420	422	420	430
pH (units)	7.8	7.9	8.0	8.0
Alkalinity (mg/l)	191	195	195	199
Total P (mg/l)	0.011	0.012	0.013	0.014
Dissolved P (mg/l)	0.007	0.008	0.008	0.009
NO_2 + NO_3 (mg/l)	0.170	0.180	0.170	0.210
Ammonia (mg/l)	0.290	0.307	0.310	0.320

ALL VALUES

Secchi disc (inches)	84	141	136	204

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
06/22/72	1. Fragilaria	658
	2. Oocystis	232
	3. Gloeocapsa	188
	4. Chroococcus	138
	5. Achnanthes	130
	Other genera	297
	Total	1,643
08/19/72	1. Chroococcus	2,278
	2. Aphanothece	995
	3. Flagellates	235
	4. Dinobryon	181
	5. Microcystis	54
	Other genera	235
	Total	3,978
11/10/72	1. Dinobryon	170
	2. Microcystis	141
	3. Flagellates	126
	4. Asterionella	119
	5. Fragilaria	61
	Other genera	273
	Total	890

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
06/22/72	01	4.9
08/19/72	01	4.1
11/10/72	01	5.2

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.007	0.416	0.2
0.006 P	0.013	0.416	0.6
0.012 P	0.019	0.416	2.9
0.024 P	0.031	0.416	7.7
0.060 P	0.067	0.416	10.7
0.060 P + 10.0 N	0.067	10.416	27.2
10.0 N	0.007	10.416	0.2

2. Filtered and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.006	0.426	0.1
0.010 P	0.016	0.426	1.3
0.020 P	0.026	0.426	4.4
0.050 P	0.056	0.426	10.3
0.250 P + 0.5 N	0.031	0.926	5.6
0.050 P + 1.0 N	0.056	1.426	12.7
1.0 N	0.006	1.426	0.1

3. Discussion -

The control yield of the test alga, Selenastrum capricornutum, in the autoclaved-filtered assay indicates the potential primary productivity of Middle Lake was relatively low at the time the sample was collected (11/10/72). Also, the results of both assays indicate the lake was phosphorus limited at that time. In each assay, yields increased with increased levels of orthophosphorus, but no yield response resulted when only nitrogen was added.

The lake data indicate phosphorus limitation at the other sampling times as well; i.e., mean N/P ratios were greater than 40/1, and phosphorus limitation would be expected.

V. LITERATURE REVIEWED

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Poff, Ronald J., and C. W. Threinen, 1961. Surface water resources of Walworth County. WI Cons. Dept., Madison.

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VI. APPENDIX

APPENDIX A

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/09/30

556901
42 46 30.0 088 34 00.0
MIDDLE LAKE
55 WISCONSIN

11EPALES 2111202
5 0042 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/22	16 40	0000	21.8	9.8	84	335	8.60	188	0.060	0.090	0.011	0.009
	16 40	0020	11.9	12.6		355	8.40	204	0.260	0.080	0.010	0.008
	16 40	0034	6.3	6.0		410	7.60	245	0.330	0.300	0.011	0.008
72/08/19	17 50	0000			204	350	8.40	166	0.060	0.060	0.011	0.006
	17 50	0004	27.2	9.1		345	8.40	166	0.060	0.070	0.010	0.006
	17 50	0015	22.3	8.4		345	8.40	165	0.070	0.070	0.008	0.005
	17 50	0022	16.3	10.2		380	8.00	212	0.190	0.110	0.008	0.005
	17 50	0027	10.7	7.1		410	7.60	228	0.280	0.260	0.010	0.006
	17 50	0035	7.9	0.8		440	7.30	240	0.200	0.620	0.012	0.006
	17 50	0046	6.0	0.0		480	7.20	262	0.050	1.760	0.024	0.008
72/11/10	11 50	0000			136	430	8.00	191	0.170	0.320	0.011	0.007
	11 50	0004	7.5	9.1		420	8.00	195	0.170	0.310	0.013	0.008
	11 50	0015	7.5	8.9		420	8.00	193	0.170	0.310	0.013	0.009
	11 50	0025	7.5	8.8		420	7.90	194	0.170	0.300	0.014	0.008
	11 50	0038	7.4	8.8		420	7.80	198	0.190	0.290	0.012	0.008
	11 50	0045	7.1	8.9		420	7.80	199	0.210	0.310	0.012	0.009

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/22	16 40	0000	4.9J
72/08/19	17 50	0000	4.1J
72/11/10	11 50	0000	5.2J

J VALUE KNOWN TO BE IN ERROR